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# UNITED STATES PATENT OFFICE.

FRANCIS I. DU PONT AND ERNEST DU PONT, OF WILMINGTON, DELAWARE, ASSIGNORS, BY MESNE ASSIGNMENTS, TO U. S. F. POWDER COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

## SMOKELESS EXPLOSIVE POWDER AND PROCESS OF MAKING SAME.

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The object of our invention is to produce a smokeless explosive powder which, when used as a propellant charge in a gun, will approximately eliminate, or at least very materially reduce, the muzzle flash. To accomplish this object, there is one essential thing which should be none. Since illuminating flames from the burning of compounds containing carbon owe their luminosity to the presence of minute particles of carbon, heated to incandescence in the act of combining with oxygen, it is obvious that to reduce the flash it is necessary to provide conditions where the carbon in the smokeless powder will all, or nearly all, combine with the oxygen set free in the reaction of combustion before the gaseous mass emerges from the muzzle of a gun.

With propellant powders now in use, those composed substantially entirely of nitrocellulose have an actual deficiency of oxygen below that which would be necessary to burn all of the carbon. The result is that minute particles of carbon, intensely heated, actually escape from the muzzle of a gun and combine with the oxygen of the atmosphere in precisely the same way as do the particles of carbon in an ordinary jet of illuminating gas. This produces an enormous and brilliant flash of light at the muzzle of a gun when firing.

Those propellant powders, such as the English cordite, which contain nitroglycerin, have always been used in guns with small chambers and have not been manufactured in such form that the density of loading will be low with uniform distribution of the powder through the chamber of the gun.

We have discovered that if existing nitrocellulose propellants are modified so that they will have a much lower carbon content in proportion to the oxygen content and if, with uniform distribution of the charge through the chamber of a gun, the density of loading is reduced at least 15 per cent, and preferably about one third, below that required for smokeless powder composed exclusively of nitrocellulose, the muzzle flash is much reduced and in fact is nearly eliminated.

The process of making our improved propellant and its essential ingredients and characteristics will now be described.

The constituents of the finished product are nitrocellulose, nitrate of ammonia and nitroglycerin; the nitrocellulose being in a colloided condition and forming an integral body enclosing the particles of nitrate of ammonia. The first two constituents named are essential, the last merely optional. The following are examples of compositions which give the results sought, it being understood that the proportions specified are preferable merely and may be varied within rather wide ranges.

I.

| | Grams. |
|---|---|
| Nitrocellulose | 55 |
| Nitrate of ammonia | 15 |
| Nitroglycerin | 30 |

II.

| | Grams. |
|---|---|
| Nitrocellulose | 33⅓ |
| Nitrate of ammonia | 33⅓ |
| Nitroglycerin | 33⅓ |

III.

| | Grams. |
|---|---|
| Nitrocellulose | 75 |
| Nitrate of ammonia | 25 |

In the manufacture of the first two compositions we use as a solvent alcohol, ether and acetone. Where nitroglycerin is omitted, it is unnecessary to use any solvent other than the usual ones employed in the manufacture of smokeless powder, namely: alcohol and ether. In Composition I we use about 32.2 grams of ether, 18.4 grams of alcohol and 2.8 grams of acetone. In Composition II we use about 29.5 grams of ether, 16.5 grams of alcohol and 2 grams of acetone. In Composition III we use about 81.4 grams of ether and 40.6 grams of alcohol.

The new powder is capable of being manufactured by essentially the same process as that used in the manufacture of ordinary

smokeless powder, but the invention is not limited to powder manufactured by any particular process.

The use of acetone in connection with the alcohol and ether solvent is in itself, we believe, an important, as well as a new discovery. While nitrocellulose of the kind usually used for smokeless powder and nitroglycerin are both soluble in the mixture of two volumes of ether to one of alcohol usually employed to dissolve nitrocellulose, nevertheless the formation of a thorough union of the nitroglycerin with the nitrocellulose, particularly where the per cent of nitroglycerin is large, is difficult.

We have discovered that if ever so little acetone is added, a very marked effect is observed in the homogeneity and fluidity of the mass.

We prefer to use acetone in this connection in the proportion of about 5 per cent of the weight of the nitrocellulose used. The addition of acetone results in the production of a colloided clear and homogeneous appearing, plastic mass, that can readily be pressed and shaped. Nitrate of ammonia, not being soluble in the solvents mentioned, remains undissolved and is contained in the clear and homogeneous appearing colloided mass in the form of included crystal fragments; these crystal fragments, so to speak, forming and occupying cells in such mass. While acetone is comparatively scarce and expensive, the quantity required to be used is relatively very small.

Having manufactured the explosive as above described the next step is the formation of the same into perforated powder grains. It is necessary that the perforations, whether they are formed mechanically or otherwise, shall be substantially larger than those existing in smokeless powder composed substantially exclusively of nitrocellulose; that is, the weight of the grains, relatively to the volume they occupy, must be substantially reduced. In other words, the density of loading must be relatively low. The charge for the present six pounder gun is 615 grammes and the cartridge case, when filled with water, holds 807 grammes. The density of loading is, therefore, approximately 762 grammes per cubic decimeter. With our powders the density of loading may be reduced to 500 grammes per cubic decimeter or even less. This is accomplished, as above stated, by providing larger perforations in the unitary pieces, or "grains," as they are called.

A great practical advantage in our powder is that the chambers of nearly all modern guns have been made large for the purpose of accommodating charges of nitrocellulose powder, so that this fact enables us to use the low density of loading without altering the design of guns.

The new propellant embodying our invention possesses other advantages.

It is more efficient, in that a smaller quantity, by weight, is required to load the gun, because of more complete combustion while work is being done upon the projectile.

It contains a large per cent of a cheap ingredient and therefore the ingredients as a whole are less expensive.

When it contains a tangibly less per cent of that substance—nitrocellulose—which is subject to spontaneous decomposition, it is more stable.

It is obvious that the advantages of our invention may be secured in some degree by reducing the proportion of nitroglycerin or ammonium nitrate, or both, if both be used. But our invention does not contemplate the reduction in the proportions of both these ingredients to a point where the increase in the oxygen content over that of smokeless powder composed substantially wholly of nitrocellulose is not quite substantial. The nitroglycerin, however, may be entirely eliminated, provided the proportion of ammonium nitrate exceeds 15 per cent. If the powder contains a substantial proportion of nitroglycerin the proportion of ammonium nitrate may be reduced as low as five per cent and the powder will still exhibit a substantial advantage over ordinary smokeless powder. It is not desirable, however, to reduce the proportion of nitrocellulose much below one-third, and about twenty per cent of nitrocellulose may be regarded as an absolute minimum. The nitrocellulose (with or without the nitroglycerin) furnishes the colloided body in which the ammonium nitrate is distributed. There is no upper limit to the percentage of nitrocellulose except that, of course, it cannot even approximate 100 per cent and give any real advantage over ordinary smokeless powder.

It is clear, as above stated, that if only nominal percentages of nitroglycerin and ammonium nitrate are contained in the finished product, the advantage of decrease of required loading density would be nominal, and, in view of the additional ingredient or ingredients required in the process of manufacture, neither the process nor product could be regarded as possessing any real utility. It may be questioned whether a reduction of the necessary density of loading by materially less than fifteen per cent would, in view of the considerations above named, be really useful; and our invention, in its preferred form, involves a decrease in the necessary density of loading of about fifty per cent. In other words, the distinguishing characteristics of our improved smokeless explosive are that it contains substantial proportions of nitrocellulose and ammonium nitrate and preferably, also,

nitroglycerin and that it has a density of loading at least fifteen per cent less than, and preferably only about two thirds of, that required for smokeless powder composed approximately entirely of nitrocellulose.

The term "grains" is used herein in its broader significance to comprehend units of any size or shape adapted to be used as a propellant charge in a gun.

Having now fully described our invention, what we claim and desire to protect by Letters Patent is:

1. An improved granular smokeless powder containing nitrocellulose and also an explosive ingredient having a substantially higher content of oxygen than nitrocellulose, the grains having perforations which give the powder a density of loading at least fifteen per cent less than that required for smokeless powder composed substantially wholly of nitrocellulose.

2. An improved granular smokeless powder containing nitrocellulose and also an explosive ingredient having a substantially higher content of oxygen than nitrocellulose, the grains having perforations which give the powder a density of loading approximately two-thirds of that required for smokeless powder composed substantially wholly of nitrocellulose.

3. An improved smokeless powder containing nitrocellulose and ammonium nitrate and formed into grains having perforations giving the powder a density of loading substantially less than that required for smokeless powder composed substantially wholly of nitrocellulose.

4. An improved smokeless powder containing nitrocellulose, ammonium nitrate and nitroglycerin and formed into grains having perforations giving the powder a density of loading substantially less than that required for smokeless powder composed substantially wholly of nitrocellulose.

5. An improved smokeless powder containing nitrocellulose, ammonium nitrate and nitroglycerin in substantially equal parts.

6. The process of making smokeless powder which consists in adding to nitrocellulose a less amount of an explosive ingredient having a substantially higher content of oxygen than nitrocellulose and also solvents one of which is acetone, and colloiding.

7. The process of making smokeless powder which consists in adding to nitrocellulose ammonium nitrate, nitroglycerin, alcohol, ether and acetone and forming a colloided body with the aid of such nitrocellulose.

8. The process of making smokeless powder which consists in adding to nitrocellulose ammonium nitrate, nitroglycerin, alcohol, ether and acetone, the proportion of acetone being small relative to either of the other two solvents.

9. The process of making smokeless powder which consists in adding to nitrocellulose an explosive ingredient having a substantially higher content of oxygen than nitrocellulose and also solvents one of which is acetone, and then forming the mixture into grains provided with perforations giving to the powder a density of loading substantially less than that required for a smokeless powder composed substantially wholly of nitrocellulose.

10. The process of making smokeless powder which consists in adding to nitrocellulose ammonium nitrate, nitroglycerin, alcohol, ether and acetone, and then forming the mixture into grains provided with perforations giving to the powder a density of loading substantially less than that required for smokeless powder composed substantially wholly of nitrocellulose.

11. As a new smokeless and flashless powder, a colloided body of nitrocellulose of clear and homogeneous appearance, said body containing included a minor portion of particles of ammonium nitrate.

In testimony of which invention, we have hereunto set our hands, at Wilmington, Delaware, on this 7th day of June, 1918.

FRANCIS I. DU PONT.
ERNEST DU PONT.